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Emerging dimensions of sustainability in institutes of higher education in India

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Abstract

The institutions of higher education provide role models for excellence in education. But also have the added responsibility of providing guidance to the community for social upliftment and environmental sustainability. It becomes imperative, therefore to assess the extent to which sustainable practices have been adopted in these institutions and their adequacy. It is anticipated that a holistic assessment will indicate strengths and weaknesses in sustainability practices so that effective measures can be taken to initiate the creation of a more sustainable environment. To achieve the foregoing objective parameters like Land use and Energy have been identified. An analysis of the basic sustainability parameters with regard to the various institutional surveys indicates the changing trends over the years. The trend reflects institutional growth, improvement in the economy and growing of awareness of sustaining the ecological environment. However, the extent to which each parameter is addressed varies from institution to institution, as well as the geographical location and climatic variations due to the diverse nature of these two factors in the Indian context. Increasing awareness issues pertaining to sustainability in institutions of higher education is reflected by relevant practices adopted, however it is expected that initial momentum generated in this direction will lead to further adoption of sustainable practices consistent with the cultural geographical and socio economic scenario prevailing.

Keywords: Land use; Energy consumption; Campus sustainability; Higher education

1. Introduction

Educational campuses are a part of the urban ecosystem. It is important to gauge various activities within a higher educational campuses with regard to sustainability, within the immediate environ-the campus, so that they may be groomed to shoulder the responsibility towards achieving a sustainable environment. A clearer understanding of the need for sustainability and how it can be achieved will to some extent enable to contribute towards a sustainable planet-to which the need is increasing with the passage of time. Sustainability as applicable to Higher Educational Campus is a process of developing and managing campuses through efficient use of renewable resources and other green practices. Sustainability practices differ from campus to campus and the perception about the sustainability differs from person to person. Some believe that they have

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met the challenges of sustainability through signing National or International declarations (Wright, 2002) and for some; it may be limited to introducing Master plans, Environmental plans, Environmental guidelines etc. (Velazquez et al., 2006). Energy consumption per square foot has been analysed for Rowan University (Peter et al., 2004). Works have been reported in Japan on the verification of energy consumption through investigations of energy consumed in the entire campus (Watanabe et al., 2005). A study was also conducted to review all the Chinese practices on establishing green universities including best practices and relevant policies. Another study called, a systems transformation analysis of seven case studies from seven worldwide universities was conducted and the evaluation was based on tri-dimensional Framework-Level-Actors (FLA) (Ferrer-Balas et al. (2008). Lukman et al. (2009) evaluated environmental performance of the University of Maribor on the basis of life cycle analysis. Ozawa-Meida et al. (2013) conducted a consumption based carbon footprint study for the UK University. Environmental Management System (EMS) was adopted by European Universities (Disterheft et al., 2012; Shaila et al., 2012). Emphasis more on Physical planning & Lad use structure to make the campus more sustainable. Built spaces require energy to carry out various activities within. Energy is an important parameter which measurably contributes in making the campuses more sustainable. As the student's intake increases, new buildings are constructed resulting in an increase in the energy consumption. Various studies have been conducted on energy consumption structures to investigate the critical areas. Educational campuses cover a huge area where they have the higher potential of generating the energy from various renewable energy resources like Biomass, Solar thermal, Solar photovoltaic, Geothermal and Wind energy (Shaila et al., 2012).

2. Introduction to study area

Campus Sustainability in India is in its very nascent stage, not having been recognised even by many of the leading institutions at National level. Case study approach is employed in this paper, to identify Land use structure and actual Energy consumption structure along with sustainability initiatives undertaken. Indian Institute of Science (IISc) Bengaluru India and Indian Institute of Technology Kanpur (IITK) were selected located in different climatic zones (Fig. 1).

Brief profile of the institutions was collected from the respective institutions as shown in Table 1. Total population of Student, Faculty and Staff was collected from Dean Academics of the respective institutions to calculate per capita consumption of energy. Population trend over five years (2007–2012) of Student, Faculty and Staff is taken for study by considering 2007 as a baseline year (Fig. 2).

3. Data collection

Data were collected from administrators and service providers with regard to the quantities associated with each parameter and the measures adopted to make the environment sustainable. The data so collected, especially with regard to quantification of parameters were lacking consistency. IITK had adopted a data centric approach in keeping with emerging trends where as IISc had, maintained records based on past practices.

Based on the information provided by the institution, required data have been calculated. Like, in IISc, Plinth area is calculated based on AutoCAD Drawing of Campus Master Plan and to calculate built up area building photographs are taken to observe the number of floors. Thus, Built up area is calculated by multiplying plinth area by number of floors. Areas covered under roads, playgrounds, forest/farm land and unmanaged green spaces is calculated based on the AutoCAD drawing of Campus Master Plan.

Similarly, detailed data were not available in IISc, related to monthly power consumption in buildings like Institutional/Administrative, hostels and other facility buildings from the year 2007 to 2012. Whereas IITK, has detailed power consumption data on all types of buildings present in it (Table 2).

4. Methodology

The two select campuses lie in two different climatic zones of India. The select campuses were visited personally and primary data are collected from various departments of the institutions both by online and offline. Focus is given on Land use structure and Energy consumption structure; further detailed area covered under all the buildings was considered for their percentage distribution with respect to total campus area. Per capita distribution of area under various land uses has been calculated for both the institutions for comparative analysis. Data on Power consumption structure from 2007 to 2012 are considered to study the consumption trends and further per capita Power consumption has been calculated to draw the inferences. Finally, per student built area provided by the institutions is correlated with the per capita Power consumption to draw inferences.

4.1. Land use structure

Land use structures of both the institutions are analysed in two ways namely; Total built up area analysis and area covered by plinth area (footprint area) analysis. Built up area of buildings are grouped into four zones namely; Institutional and Administrative, Hostel, Staff quarters and Facility buildings. Foot print area of Land uses are grouped into ten zones namely; Institutional and Administrative, Hostels, Staff quarters, Facility buildings, Roads, Playgrounds, Forest/Farm land, Managed green spaces, Unmanaged green spaces and Water body. Depending on the areas being utilised by occupants in

Figure 1. Location of study area on geographical map of India.

Table 1
Brief profile of the institutions.

Description	IISC	IITK
Type of institution	Residential	Residential
Year of establishment	1902	1959
Total area	178 ha.	426.90 ha
Student population (2012)	3237	11,257
Faculty population (as on 2012)	486	354
Staff population (as on 2012)	763	570
Total campus residents (as on 2012)	8086	15,881
Student:faculty	1:7	1:13
Type of programmes	UG, PG, PhD, (Recently introduced)	UG, PG, PHD
Funding by central government	Fully funded	Fully funded

Note: UG – Under Graduate, PG – Post Graduate and PhD – Doctor of Philosophy. *source*: Annual Reports of Indian Institute of Science (2007-2012) and Annual Reports of Indian Institute of Technology (2007-2012).

various zones built up (b/up) area per occupant and foot print area per occupant are calculated (Table 3).

Depending on the results obtained built up area/occupant (Fig. 3) and foot print area/occupant (Fig. 4) of various land uses in both the institutions are compared to draw the inferences.

4.2. Energy consumption structure

Electricity being consumed for various purposes like; Lighting, Power system, Air Conditioning system (AC),

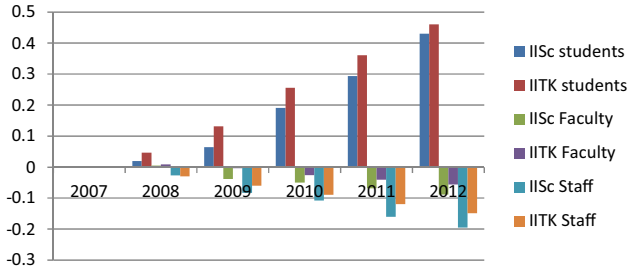

Figure 2. Population of Student, Faculty and Staff trend over the five years in IISc and IITK.

Table 2
Status of data availability in institutions of IISc and IITK.

Data	Available	Not Available
Land use as on 2012		
Total built up area of Institutional/Administrative buildings, Hostels, Staff Quarters, Other Facility Buildings and **Total built up area of the campus**	IITK	IISc
Total foot print area of Institutional/Administrative buildings, Hostel Buildings, Staff Quarters, Other Facility buildings and **Total footprint area of the campus**		
Total area covered under Roads and Play Grounds	IITK	IISc
Total area covered by Forest/farms		IISc, IITK
Total area covered by Managed green spaces	IITK, IISc	
Total area covered by Unmanaged green space		IISc, IITK
Total area covered by Water body	IISc,	
Total campus area	IITK, IISc	
Energy		
Month wise power consumption by Institutional/Administrative buildings from 2007 to 2012	IITK	IISc
Month Wise Power consumption by Hostels from 2007 to 2012	IITK	IISc
Month Wise Power consumption by Staff Quarters	IITK, IISc	
Month Wise Power consumption by Other Facility buildings	IITK	IISc
Month Wise Power consumption by entire campus-2007–2012	IITK, IISc	

Water heating, Cooling, and others. For the purpose of comparative energy consumption analysis, monthly energy consumption of entire campus from the year 2007 to 2012 was collected from both the institutions. Detailed monthly energy consumption of all buildings was not available in IISc where as IITK has maintained detailed monthly Energy consumption of all buildings present in the campus. Due to lack of data, available, only total monthly power consumption for the entire campus is considered for the comparison. Fig. 5 shows average yearly energy consumption (2007–2012) in campuses of IISc and IITK. Fig. 6 shows average monthly power consumption units for the year 2012.

Student, Faculty and Staff population (2007–2012) in both the institutions shows a considerable increase in student population where as faculty and staff population is

Table 3
Land use structure of IISc and IITK campuses.

	IISc			IITK		
	Built up Area					
	Area in Sqm	b/up area(%)	b/up/occupant	Area in Sqm	% of b/up area	b/up/ occupant
Institutional/administrative (student, faculty and staff)	319139.44	50.47	71.14	144,944	29.05	11.90
Hostels (Students)	177913.50	28.13	54.96	183,800	36.84	16.33
Staff Quarters (faculty and staff)	116107.72	18.36	23.24	118,920	23.84	25.85
Other Facilities (student, faculty and staff)	19226.30	3.04	2.33	51,263	10.27	3.23
Total built up area	632386.96	100	151.68	498,927	100	57.31
	Foot print area					
	Area in Sq m	Footprint area (%)	Foot print/ occupant	Area in Sq m	Footprint area (%)	Sqm/ Occupant
Institutional /administrative (student, faculty and staff)	149739.54	9.25	33.36	79,695	1.87	6.54
Hostels (students)	40064.6	2.47	12.38	81,577	1.91	7.25
Staff quarters (faculty and staff)	54566.02	3.37	10.92	79,230	1.86	17.22
Other facilities (student, faculty and staff)	19226.3	1.19	2.33	44,073	1.03	2.78
Total	263596.46	16.28	54.41	284,575	6.67	25.65
Roads (residents)	448142.2	27.68	5.00	407,402	9.54	25.35
Playgrounds (residents)	41190.1	2.54	63.89	402,550	9.43	0.00
Forest/farms (residents)	526233.4	32.50	9.25	0	0.00	94.78
Managed green space (residents)	76221.4	4.71	51.27	1,505,186	35.26	105.11
Unmanaged green space (residents)	261419.54	16.15	0.28	1,669,287	39.10	0.00
Water body (residents)	2336.9	0.14	33.36	0	0.00	6.54
Total campus area	1,619,140	100.00	243.11	4,269,000	100.00	284.68

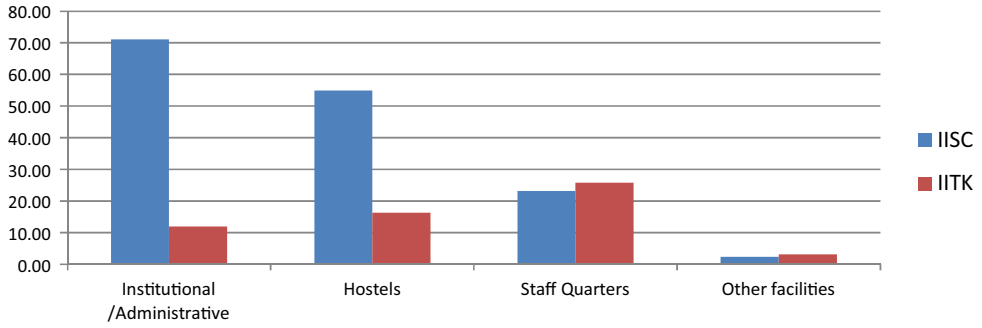

Figure 3. Built up area/occupant of various Land uses in IISc and IITK.

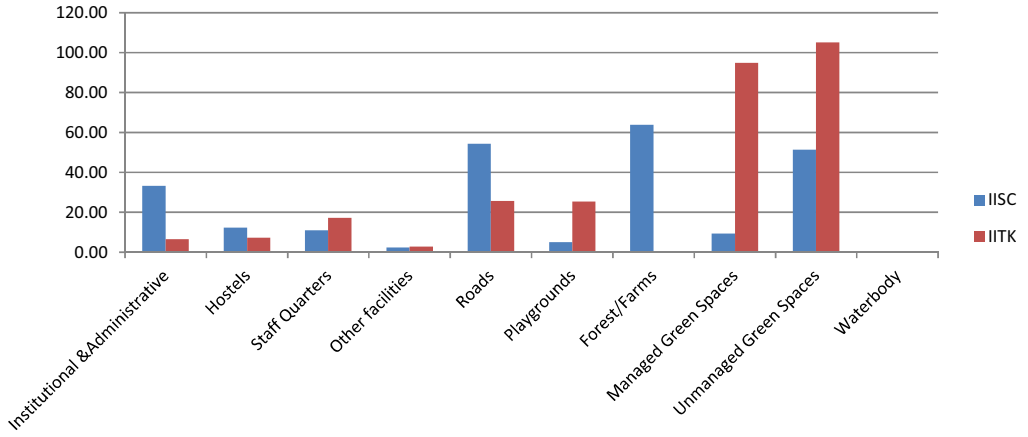

Figure 4. Foot print area/occupants of various Land uses in IISc and IITK.

decreasing (Fig. 2). As compared with the faculty, population of staff is more thus over the years whereas population of both faculty and staff is almost constant. Thus total power consumption/student population is considered for calculation to analyse the trends (Fig. 7).

Finally, total built area/capita provided by both institutions is correlated with the power consumption/capita to draw inferences (Fig. 8).

4.3. Sustainability initiatives

IISc has installed solar water heaters for the entire new hostel and in some places LED lighting is used specially in the corridor, 2 KW solar panel is being installed to generate the energy. Field observation shows various measures like use of solar water heater for all the hostels, Solar photo-voltaic cells, for street lighting, Led's, energy star rated appliances within the campus. IIT Kanpur is also working on the solar-park projects to generate electricity through various innovative techniques.

5. Discussions

Two of the selected institutions almost perform similar function, both are fully residential, technical and research oriented and totally funded by the Government of India.

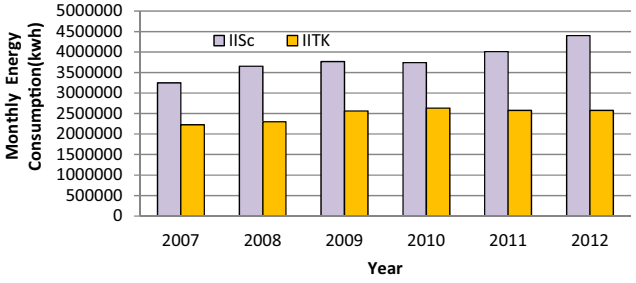

Figure 5. Average yearly energy consumption of IISc and IITK from 2007 to 2012.

Land use structure analysis shows that, various spaces designed per occupant differ from zone to zone as well as there is no similarity between the zones also. Which shows that are is no set of guidelines for designing various spaces of the educational institutions. Built area analysis shows that, IIsc has provided more space per occupant for institutional/administrative and hostels. Whereas built-up area provided per occupant for staff quarters and for other facilities are almost same. Similarly footprint per occupant provided for institutional/administrative areas and for hostels is more in IISc and compared with the IITK which shows that more of open land is being utilised for constructing the building. IITK has provided more per occupant area for

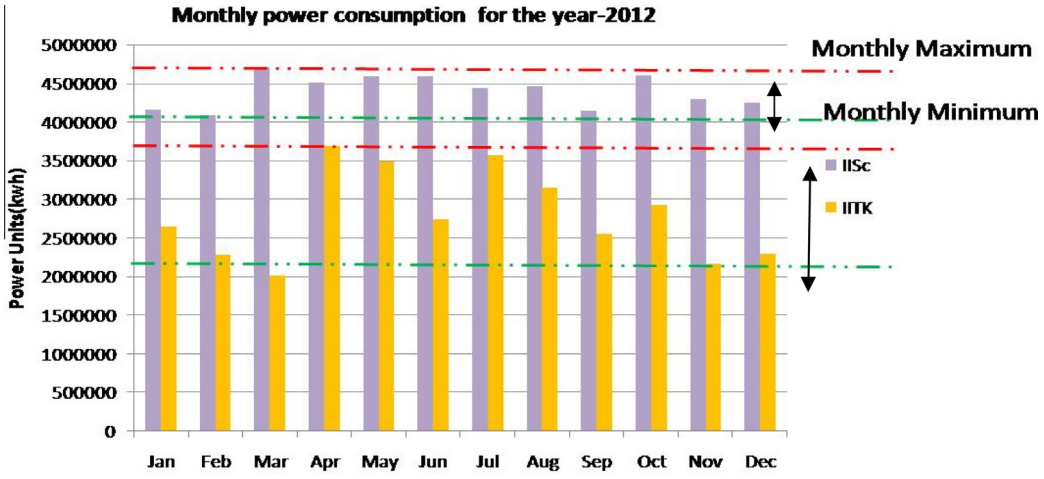

Figure 6. Monthly power consumption of IISc and IITK for the year 2012.

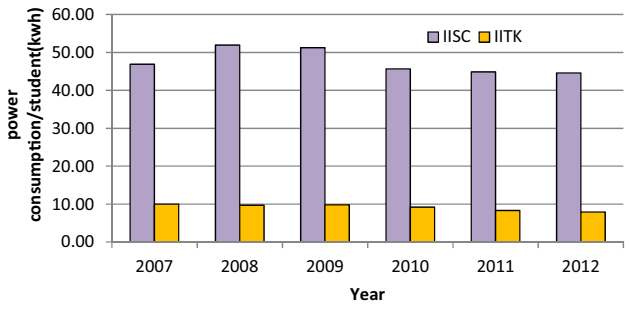

Figure 7. Power consumption/student in IISc and IITK from 2007 to 2012.

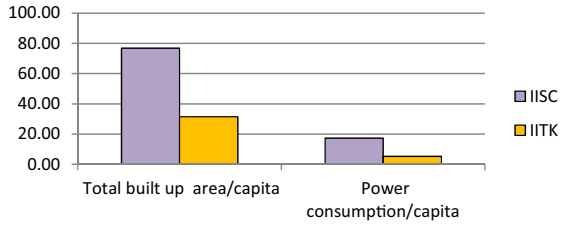

Figure 8. Per capita built-up area and power consumption in IISc and IITK.

the staff residences. Similar spaces were noticed for other facilities. All physical plan of the IISc shows a very scattered type of planning which has resulted in an increase in percentage of road area as compared to the overall campus area. Total population of IISc is less as compared with the IITK thus playground area/occupant is more in IISc as compared to the IITK. Managed green spaces include lawns and other green areas which require a regular maintenance and this area is more in IISc. Unmanaged green spaces include which does not requires any maintenance and this area is more in IITK. The footprint area of both the campuses shows that there is still more that 50% open land present (play grounds, green spaces and water body) within the campus which can be utilised for resource generation. Also the future vertical growth will ensure to maintain at least same percentage of open land. The study has also been conducted on power consumption structure for five years which shows an increase in the power consumption every year. Maximum power consumption is due to heating and cooling equipments, use of Air conditioners, Heavy duty lab equipments, Kitchen equipments in hostels. Power consumption/student for both the campuses decreases with increase in time. Various factors influence this trend namely; (1) use energy efficient gadgets at individual level. (2) Replacing few LED's with existing CFL's. (3) Student faculty ratio (4) distribution of constant power demands amongst the total users (5) Use of alternative renewable energy resources etc. Further comparison of total built up area/capita and daily power consumption/capita is shows a very strong correlation, which indicates that increase in per capita built space will increase the per capita power consumption. Providing extra spaces will increase the load of lighting, fans, heating/cooling. But this cannot be true to constant power demand areas which include heavy duty machines of lab equipments, various kitchen equipments in hostel messes etc.

6. Conclusion

In this paper, two educational institutions were studied with respect to land use structure and power consumption to assess the extent of their efforts towards Campus sustainability. The conclusions based on the limited study conducted are as follows:

1. Regional features like climate, social structure and culture embedded with dominating traditional values influence the approach adopted to attain Campus Sustainability.
2. Newer institutions have more organised data management as compared to the older institutions.

3. The student faculty ratio varies depending on the type of programmes conducted by the Institution i.e. Institutes having greater emphasis on research programmes have a lower student faculty ratio as compared with the institution with emphasis on undergraduate and postgraduate academic programmes.
4. Scatter type of planning in older campus has resulted in greater built-up area as compared with the compact planning adopted by the newer campus.
5. Built-up area of institutional and hostel area per occupant is more in Institute with research programme as compared with other programmes. Whereas built up area of staff quarters and facility building areas remains the same to a great extent.
6. Foot print area/occupant varies from campus to campus indicating no cohesive approach or absence of guidelines.
7. There is an increase in energy consumption over the years in the older Institution whereas in the newer Institution it is almost constant.
8. Emerging sustainability awareness amongst the stakeholders and implementing energy efficient appliances have resulted in decreasing the power consumption/student over the years indicating that the traditional older Institutions are realising the importance of Campus sustainability and adopting similar measures as the newer Institutions.
9. It is anticipated that the growing awareness of Campus Sustainability will, in time, influence appropriate efforts with regard to data collection and collation, planning and execution to be extended to other sustainability parameters to an appreciable extent.

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Further reading

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